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The undersigned declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing therefrom.

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Name of applicant, assignee or Registered Representative

Max Fogiel
Signature

6-4-01
Date of Signature

Thomas J. Snow

Thomas J. Snow

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1 METHOD OF MANUFACTURING PISTONS AND COMPONENTS THEREOF, AND

2 FORCING TOOL

3 The present invention concerns a method of manufacturing
4 pistons and components thereof, piston heads for example,
5 especially intended for internal-combustion engines.

6

7 German A 3 801 847 discloses a method of manufacturing
8 pistons for internal-combustion engines, each piston being
9 provided with at least one metal reinforcement. The
10 reinforcement, of a material with open pores, is heated and
11 introduced into a heated die. A prescribed amount of aluminum
12 or aluminum alloy is injected into the die. A plunger is
13 introduced into the die, compressing the cooling melt. The
14 compressed melt flows around the reinforcement and fills both
15 the piston mold and the reinforcement's pores. Once the melt
16 has hardened, the piston is removed from the die along with
17 the reinforcement and machine finished.

18

19 A piston especially intended for internal-combustion engines
20 is known from German A 19 935 410. This piston features a
21 shaft with a bore for a bolt and an adjacent annular field.
22 Webs extend from the bore toward the annular field and/or
23 toward the end of the shaft remote from the field. Pistons of
24 this type are preferably cast.

25

1 German A 3 222 582 describes a method of manufacturing a
2 base for a multiple-component piston, especially intended
3 for large diesel engines. The center of the base is domed
4 and surrounded by a shoulder and has an interior hub. The
5 shoulder accommodates piston rings and rests against a
6 separate piston shaft, onto which the hub can be screwed
7 and/or welded. In this method a bowl with an area that
8 matches the shape of the piston's center and has a
9 surrounding collar is in an initial shaping step forged
10 from a heat-resistant steel. The shoulder and the hub are
11 then in a subsequent shaping step forged out of the collar.
12 This approach, which involves forging axially in terms of
13 the piston's base, however, allows only contours with
14 prescribed wall thicknesses, especially radial wall
15 thicknesses, and the product is heavy and requires a lot of
16 material.

17
18 The object of the present invention is a method of
19 manufacturing pistons and components thereof, piston heads
20 for example, whereby the easily worn-down aluminum skirts
21 are eliminated, less material is required, and the pistons
22 or components will be simple to manufacture with ideal wall
23 thicknesses. Another object of the present invention is a
24 forging tool that can be employed to easily manufacture
25 such pistons or components of even complex designs.

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23 forging tool that can be employed to easily manufacture such
24 pistons or components of even complex designs.

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1 This object is attained in accordance with the present
2 invention in a method of manufacturing pistons and components
3 thereof, piston heads for example, especially intended for
4 internal-combustion engines, wherein in an initial
5 manufacturing stage a blank that will eventually constitute
6 the piston or piston component is preliminarily forged along
7 a prescribed axis, shaping appropriate contours, and wherein
8 in at least one subsequent manufacturing step the
9 preliminarily shaped piston is finally forged along at least
10 one other axis, creating additional contours.

11
12 Advantageous further embodiments of the method in accordance
13 with the present invention are addressed in the associated
14 subsidiary claims herein.

15
16 The same object is also attained in accordance with the
17 present invention in a forging tool comprising various tool
18 parts in the vicinity of the upper and lower die halves,
19 whereby these tool parts can be advanced within planes
20 defined by axes toward a blank for the purpose of
21 preliminarily and finally shaping pistons and components
22 thereof and whereby tool parts of at least one die half are
23 employed for preliminary forging and tool parts of at least
24 one die half are employed for final forging.

25

1 Advantageous further embodiments of the forging tool in
2 accordance with the present invention are addressed in the
3 relevant subsidiary claims herein.

4

5 In a departure from the method of manufacture described in
6 German A 3 801 847, accordingly, a steel blank, optionally a
7 rod, that has been produced by multiple-dimensional
8 (multiple-axis) forging in one and the same forging tool can
9 be employed in accordance with the present invention.

10 Aluminum skirts like those employed in the prior art are

11 mutually perpendicular.

12 When the shape is more complex,
13 however, the blank could conceivably also be forged over at
14 least one other plane at an angle to the aforesaid two axes.

15

16 This approach to the manufacture of a multiple-axis piston or
17 component thereof by forging solves, as hereintofore
18 mentioned, the problem of premature wear on the part of the
19 aluminum skirt typical of conventional configurations in that
20 the piston's or component's positioning skirt is steel and
21 integrated into the overall product. German A 322 582 in no
22 way intimates such a procedure. Furthermore, multiple-axis

1 forging of a blank, optionally a rod, can also produce
2 filigreed contours, which has been possible heretofore only
3 by casting, while consuming very little material.

4

5 The present invention will now be specified with reference to
6 the accompanying drawing, wherein

7

8 Figure 1 is a sketch illustrating the principle involved in
9 manufacturing piston heads,

10

11 Figure 2 is a sketch illustrating a forging tool in
12 accordance with the present invention in principle,

13

14 and

15

16 Figure 3 illustrates a piston head forged in accordance with
17 the method illustrated in Figure 1 in the forging tool
18 illustrated in Figure 2.

19

20

21 Figure 1 shows the steps involved in manufacturing a piston
22 head. A bar-shaped steel blank 1 is heated by induction for
23 example and upset in a die in axis 1'. The die can be
24 preliminarily heated if necessary. A cavity 2 is shaped out
25 of the blank in the same die and in the same direction, and a

1 radial zone 3 similarly produced. First structures 5 are
2 simultaneously shaped onto the upper face 4 of the blank.
3 Sides 6 are then shaped in, and the inner surface of cavity 2
4 optimized. Sides 6 correspond to the outer diameter of cavity
5 2. The preliminarily shaped piston 7 is then freed of excess
6 material 8. Since all the operations of reshaping and shaping
7 on hereintofore specified occur in the same axis (indicated
8 by the arrow), the shaping of blank 1 into a preliminarily
9 shaped piston 7 represents an initial manufacturing step A.

10

11 The preliminarily shaped piston 7 is now reshaped in the very
12 same forging tool. In this step the facing sides 6 are
13 radially upset, positioning them within the circumference of
14 piston 7. Any excess material 9 is removed, a procedure that
15 is, however, not always necessary but depends on the state of
16 the piston.

17

18 Figure 2 is a schematic illustration of a forging tool 10
19 with an upper die half 11 and a lower die half 12. Forging
20 tool 10 is represented open on the left and closed on the
21 right of the figure. Upper die half 11 accommodates tool
22 parts 13, 14, and 15 and lower die half 12 tool parts 16 and
23 17. The tool parts 16 accommodated in lower die half 12 can
24 be displaced in the direction indicated by the arrows by
25 hydraulic piston-and-cylinder mechanisms 18. Tool parts 13

1 and 16 slide over surfaces 19 and 20 in lower die half 12. In
2 initial manufacturing step A, upper die half 11 is displaced
3 along with its tool parts 13, 14, and 15 along the axis 1' of
4 lower die half 12. Tool parts 16 are in a position ready to
5 carry out along the perpendicular the reshaping operations
6 comprising the initial manufacturing step A represented in
7 Figure 1. Next, piston-and-cylinder mechanism 18 displaces
8 tool parts 16 along axis 1'', preparing them to carry out the
9 shaping operations comprising subsequent manufacturing step
10 B.

11
12 Figure 3 is a perspective view of a piston 7 manufactured out
13 of blank 1 over the course of manufacturing steps A and B,
14 with sides 6 inside circumference 21. Sides 6 will eventually
15 be bored through to accommodate an unillustrated bolt without
16 the use of a sleeve. This bolt will be shorter than those
17 employed in the prior art. Skirt 22 matches the circumference
18 21 of piston 7, its wall is optimally thick, and it extends
19 into the radially recessed sides 6 by way of webs 23.

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